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SEASONAL DISTRIBUTION OF SOME ACANTHOCEPHALA FROM FRESH-WATER HOSTS *

H. J. VANCLEAVE

In a recent paper Linton (1914: 48-56) has given a brief survey of the evidence on seasonal distribution of parasites of marine fishes. He concluded this paper with the statement: "There does not appear to be evidence of any marked periodicity in the occurrence of helminth parasites of marine fishes, either adult in the alimentary canal, or immature encysted in the tissues of their hosts, beyond what may be expected where fishes are exposed to varying sources of infection in the course of their migrations." In speaking of the seasonal distribution of Acanthocephala he has recorded the occurrence of *Echinorhynchus gadi* Müller (which he called *E. acus*) in *Pseudopleuronectes americanus* ". . . in every month in which examinations were made, viz., January, February, April, May, July, August, September, October, November, and December." The mere fact that a parasite is present in its final host for the greater part of, or even for the entire, year is not proof that there is no periodicity in its occurrence. One generation of parasites might overlap another generation, yet if conditions for reinfestation were such that larvae could enter the final host only at restricted periods it would be possible to detect a periodicity in the infestation upon the basis of the distinctions between immature and mature individuals. Unfortunately most records make no mention of age of the parasites. On the other hand, if the intermediate host of the parasite constitutes a part of the food of the final host throughout the year the chances for constant reinfestation make it impossible to recognize distinct cycles of infestation.

Conditions of life in fresh-water are so much more varied than in the ocean that it would not be surprising to find seasonal changes in kinds of parasites and degrees of infestation more marked in hosts from fresh water than in hosts from the ocean. Very little has been done toward establishing any correlation between extent or degree of parasitic infestation and periodicity of occurrence. The records on these topics deal almost exclusively with the general problem of the number of parasites found in a given host without further analysis beyond an occasional tabulation of the data for the classes or orders of the parasites found. A number of writers have recorded the

* Contributions from the Zoological Laboratory of the University of Illinois, No. 58.

months in which they have found *Acanthocephala* in various hosts without furnishing any data on the presence or absence of the same parasites in the same hosts at other times of the year. Thus Zschokke (1884: 58) has recorded *Pomphorhynchus laevis* (Müller) from various fishes from January to June, but he has not given any evidence or proof of its absence for the remainder of the year. In fact his records seem only to indicate the dates when he chanced to examine fish which were infested with *P. laevis* rather than to represent an attempt on his part to establish the limits of the seasons when this parasite occurs in its final host.

In collecting fresh-water *Acanthocephala* the writer has been impressed by the varying degrees of infestation of certain hosts at different times of the year. A search of the literature has furnished so little actual information upon this subject that it seemed worth while to investigate the question, especially since Linton has rather summarily dismissed the topic with a brief generalization. The records from which the following data have been gathered comprise three species of *Acanthocephala*. In one of these no marked seasonal distribution is evident, while in the other two definite seasonal cycles mark the occurrence of the parasite in its final host.

Neoechinorhynchus emydis* (Leidy) occurs in the intestine of a number of fresh-water turtles. The records of the writer and of Mr. H. W. Stunkard include the examination of over 200 individuals belonging to species susceptible to infestation with *N. emydis*. These came from Iowa, Ohio, West Virginia, Texas, and various points in Illinois. The unselected data from all the records when assembled and tabulated presented evidence of a seasonal distribution of *N. emydis*, which upon closer examination of the data proved to be spurious. Parasites of this species were recorded from hosts examined in October, November, December, January, and February with a few records of occurrence in July. Records of examinations in April, June, and September showed no infestation with this parasite. This in itself seemed to indicate a restriction of *N. emydis* in the intestine of its final host to a limited portion of the year. However, further examination revealed that certain localities within the geographical range of the species are free from that parasite. By a strange coincidence turtles happened to be examined from these localities in months when no records were available for regions where *N. emydis* is known to occur. This shows how statistical data if not carefully checked may give false evidence of cyclic occurrence of an organism.

* *Neoechinorhynchus*, Stiles and Hassall, 1905=*Eorhynchus*, VanC., 1914=*Neorhynchus*, Hamann, 1892, preoccupied.

Indirect evidence has shown that *N. emydis* occurs in the intestine of its final host throughout the year. Turtles from Havana, Ill., have been kept without food in aquaria fed by the University of Illinois water supply, which is from deep wells, for about eleven months. At the end of this time one turtle still harbored twelve mature specimens of *N. emydis* in its intestine. The evidence of an original infestation lasting practically a year, together with the fact that in many instances the writer has found fully mature, immature, and intermediate specimens in the intestine of the same individual proves that turtles in regions where *N. emydis* occurs are constantly exposed to reinfestation with that species. Consequently there is no cyclic change in the degree of infestation from month to month.

It is interesting to note that while *N. emydis* has a broad geographical distribution, occurring in the records under consideration at certain points in Illinois, North Carolina, and Texas, it is by no means generally distributed over its range. In Illinois, for example, turtles of species susceptible to infestation with *N. emydis* have been collected at Urbana, Muncie, and Chicago, and in no case has a single specimen of *N. emydis* been found. It seems strange that a species with such a broad dispersal should not have followed the dispersal of its final host. This probably finds explanation upon the grounds that in the localities where the parasite does not now occur if it was originally or subsequently introduced the embryos when expelled from the intestine of the final host were not taken up by animals in which the larvae could develop or in case they did find lodging in a host it must have been in some animal which was not used by the turtles as food. Thus through the lack of adaptability to new conditions brought on by the specialization accompanying parasitism this species has been excluded from some regions which are included within its limits of distribution.

In contrast with the lack of periodicity in the species just discussed may be noted the condition found in *Neoechinorhynchus gracilisensis* (VanC.) found in the intestine and intestinal caeca of the gizzard-shad, *Dorosoma cepedianum* (LeSueur), from the Illinois River system. During the period from 1909 to 1912 the writer examined more than 300 gizzard-shad for parasites. But two species of parasites have been found. Both of these were Acanthocephala belonging to the genus *Neoechinorhynchus*. *N. gracilisensis* has been found in October, November, December, February, March, and April, but specimens at these different dates displayed wide variation in degree of sexual maturity. Those collected in October were almost invariably small and immature, with a high percentage of infestation. By the latter part of November individuals of this species had reached full sexual maturity, as indicated by the numbers of hard-shelled embryos contained in the body cavities of the females. In April the percentage

of infestation had decreased to less than one half of that found for October, and the number of individuals per host also had decreased though every parasite had reached full sexual maturity and the maximum size for the species. Numerous examinations in the months of June, July, and August have failed to give even a single specimen of this species. From the foregoing data it is evident that the introduction of *N. gracilisensis* into the final host must occur in early fall, probably in September. The individuals have become fully mature by April and disappear entirely from the final host during the months of June, July, and August. In an earlier paper (VanCleave 1913; 181) I have indicated the probable relationship between this periodicity of infestation and the food habits of the gizzard-shad. Observations upon the stomach contents of the shad, which is primarily a scavenger, have failed to throw any light upon the probable intermediate host of this parasite. The entire digestive tract is usually filled with mud and decomposed plant tissues with a very few shelled rhizopods and some species of microcrustacea.

TABLE SHOWING SEASONAL DISTRIBUTION OF THREE FRESH-WATER SPECIES OF NEOECHINORHYNCHUS

Species	January	February	March	April	May	June	July	August	September	October	November	December
<i>N. emydis</i> *.....	+	+	X	X	X	X	+	X	X	+	+	+
<i>N. gracilisensis</i>	X	+	+	+	±	—	—	—	±	+	+	+
<i>N. longirostris</i>	—	—	—	—	±	+	+	+	X	X	+	+

* For additional experimental evidence see text.

+ Positive records of occurrence based upon examination of hosts.

— Absence from all hosts examined.

± Extremely probable occurrence. Though definite records of infestation are wanting the stage of maturity of individuals collected the preceding or the following month indicates that a complete gradation of stages in development necessitates an overlapping of infestation into adjacent month.

X records, both positive and negative, wanting though stages of maturity of the parasites in the two adjacent months together with the data upon longevity of the species in the final host justifies the assumption of a positive infestation.

Neoechinorhynchus longirostris (VanC.), the second species found in the intestine and intestinal caeca of the shad, occurs in much smaller numbers and in but a very small percentage of fishes examined. Immature individuals were found in June and July. Gravid females were found in August, November, and December. While the number of records is insufficient to permit of establishing all points in a seasonal cycle, yet the evidence at hand indicates that the host is free from parasites of this species from late winter until early summer.

In the case of both species of *Neoechinorhynchus* from the gizzard-shad the relatively short life in the body of the final host is noticeable.

Moreover, the parasites of a given species collected at the same time from a given region have all reached approximately the same stage in development. This indicates that the period when infestation may occur is very brief. Attention should also be called to the fact that periods of infestation in these two species are not coexistent.

CONCLUSIONS

1. Seasonal distribution of fresh-water *Acanthocephala* varies in different species. No general statement can be made to apply to the entire group.

2. *Neoechinorhynchus emydis* (Leidy) has broad limits of geographical distribution, but has never been found in turtles of susceptible species from some localities within its range of distribution.

3. *N. emydis* occurs in turtles from some localities at all seasons of the year.

4. The same host may harbor specimens of *N. emydis* in all stages of development between immature and fully mature. This shows the host must be exposed constantly to sources of infestation.

5. There is no cyclic change in the degree of infestation with this species from month to month.

6. *N. gracilisensis* (VanC.) enters the gizzard-shad in early fall, probably September; in April or May it attains sexual maturity and is finally expelled. During the summer the gizzard-shad is not parasitized by this species.

7. *N. longirostris* (VanC.) parasitizes the gizzard-shad in the summer, reaches full sexual maturity by midwinter, and disappears entirely from spring to early summer.

8. The demonstrable presence of a seasonal cycle in the life history of a parasite involving two or more hosts is dependent upon (a) longevity of the parasite in the final host; (b) extent of the time in which infestation of the final host may occur; (c) length of time required for development of the larva in the intermediate host; (d) seasonal changes in the food habits of the final host, or active migrations of the host to and from sources of infestation.

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